

COLAS
ROADS

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COLAS ROADS

*A Reasoned Treatise showing what
Colas is, why its use is recommended
and how it should be used*

Second Edition



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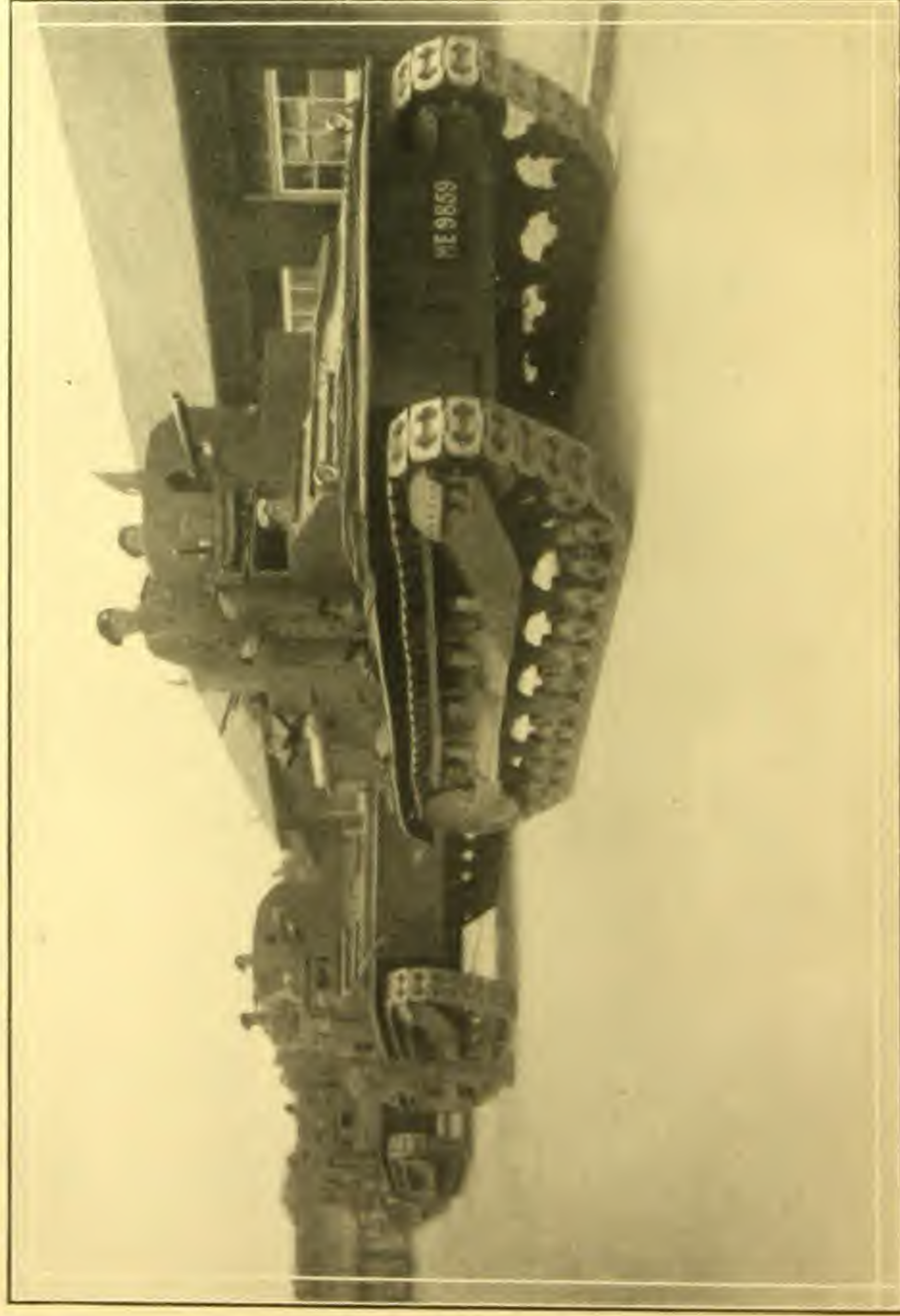
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THE TEST OF TANKS

Pinehurst Barracks, Aldershot, showing a typical example of a Colas Full Grout. Although this work was carried out in the Winter of 1923-24 and has been regularly subjected to Army Tanks, Caterpillar Tractors and Heavy Artillery traffic, the surface is still perfect. The photograph was taken in August 1928.



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PATENTS

*The processes and products of the Colas Companies are
protected under the following British Letters Patent :—*

202,021	:	202,230	:	202,235
232,683	:	236,641	:	238,967
268,411	:	248,859	:	and other

pending applications.

*Similar protection has been taken in all the principal
countries of the World.*

Introduction

MODERN traffic has put upon our highways strains and stresses that demand a road surface into which is built the ability to withstand *Shock, Abrasion, Displacement* and *Wear*.

*Modern
Require-
ments.*

Our climate demands of a road that it shall withstand *Wet, Drought, Heat* and *Frost*.

Economy demands that we shall provide for these requirements with the minimum of expenditure—measured not only in 'cost per super yard' but in 'cost per super yard *per annum*.'

Given a satisfactory aggregate, the main constituent upon which success or failure depends in road construction is the binding medium cementing the aggregate together in position.

*Importance
of the
Binder.*

If we can produce a *Binder* which is at the same time a *Waterproofer*, a *Shock-absorber* and a *Time-resister*, we have filled four of the essential requirements for a successful road surface.

If, further, we can incorporate in the binder the ability to withstand *Heat* and *Frost*, we have completely covered the physical demands of a satisfactory surface.

If we can provide this binder in a form and at a price which is economical in application, then we may surely claim that the problem is largely solved.

A vast amount of research preceded the introduction of Colas some years ago, and *Colas—the Fulfilment.* practical tests have firmly established Colas in the forefront of modern road construction and maintenance.

Colas is an emulsion of pure bitumen ; by the Colas process it is possible to emulsify any grade of bitumen which may be required for any specific purpose.

A Pure Bitumen Emulsion.

For industrial uses there are, of course, many different grades of bitumen required, but in road work it has been found that, for surface dressing and grouting work, the resultant bitumen on the stone should be of a penetration of 190-200 with a high ductility.

It is for this reason that in the manufacture of Colas a bitumen of 190-200 penetration is used.

All bitumen used in the production of Colas is specially prepared by the most modern refining process which ensures absolute uniformity and consistency. In the Colas process no materials are added which are in any way deleterious to animal or vegetable life.

Precision of Production.

Summary of Colas Advantages.

Bitumen is the best binder, and Colas is the surest and safest medium for its application and distribution.

The advantages which qualify this claim are :

1. Colas is applied cold at the same temperature as the surface or material in the road ; it saves the cost of heating, and eliminates the dangers of overheating.
2. A perfectly uniform and consistent film of bitumen results.

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THE TRAFFIC TEST

A view of Mount Pleasant Hill, Tunbridge Wells, taken from the Southern Railway Station. The road was constructed with water-bound granite and was heavily surface dressed with Colas and granite chippings. The photograph was taken after a lapse of three years during which time no further dressing was applied. Although the road carries very heavy bus and commercial traffic, including the main traffic from London to the coast, the wear has been negligible.



3. Owing to the scientific relationship between the bitumen in Colas and its vehicle (water), the most efficient film of binder is left over the stone particles. The fluidity of Colas enables an even distribution to be effected to any depth up to 3" of consolidated metal depending on the quantity used. (3" is the maximum consolidated thickness obtainable by standard rollers.)
4. Colas sets in all atmospheric conditions, though its rate of setting depends on humidity and temperature to a limited extent.
5. Colas will achieve better results than an equal quantity of hot material, while success is possible with Colas under any weather conditions other than in heavy rain or on a frost bound road.

Colas is used in the tropics and in Scandinavia with equal success, which proves the claim that with Colas there is no possible danger of picking-up or bleeding. The Colas road remains as laid, and, if the correct materials have been used, perfect travel under all conditions is ensured.

Chapter I

ASPHALT MACADAM BY THE PENETRATION METHOD

The Grouting Principle Described

IT is generally accepted that the strain on our highways resulting from intensive modern traffic has rendered the old waterbound macadam roads practically obsolete. Just as in pile-driving, where the rapid succession of blows from a steam pile-driver will take effect when the slower hand-worked monkey has none, so the greater intensity of modern traffic seriously affects roads which were fit to stand up to the traffic of former days.

*Need of
Efficient
Binder.*

While it is true that waterbound highways, constructed with a really hard aggregate and provided with an adequate sealing coat, are still giving good results, nevertheless in modern practice the solution of the problem is usually sought in the application of a binder in the body of the road and the provision of a water-proof sealing coat.

The aggregate of the road will only develop its full wear-resisting qualities provided it can be effectively held together; this result is obtained in two ways—either the aggregate is previously coated with a binder, or, by using the grouting or penetration method, the

binder can be applied to the aggregate after it has been laid in position and rolled to a greater or less extent; the amount of rolling required depends on the aggregate, on the material used as a binder and on whether the latter is used hot or cold.

The essential property of a binder is its power to hold the aggregate together and so prevent disintegration of the road.

As it is the road metal and not the binder which bears the weight of traffic, a thin film of binder rather than a thick film is desired.

*Property
of the
Binder.*

In order to obtain the maximum physical interlocking of the stone aggregate it is essential that this should consist of suitably graded road metal in right proportions, smaller sizes being necessary to reduce the voids, thus providing increased surface contact and helping to eliminate movement and internal attrition.

The surface tension between the binder and the aggregate holds the mass together. With a well-graded aggregate, the maximum surface tension is provided, and a very durable road will result if a binder is used which will penetrate the interstices between the stones.

A hot binder striking a cold aggregate cools too rapidly to penetrate the full depth of stone.

Colas, however, is applied at the same temperature as the stone and is of such fluidity as to penetrate the full depth without being in excess.

*Advantages of
Cold
Bitumen
over Hot.*

An excess of binder acts, in effect, as a lubricant during warm weather and results in local movement of the aggregate under traffic, as well as in bleeding and picking up.

Colas, by its very nature, overcomes this common

failing entirely, so that there is no fear of movement once the road surface has been consolidated.

Comparing binders, it is well known that pure bitumen has the greatest binding power owing to its high ductility and long life. Rain and snow in winter and the hot sun in summer cannot alter or destroy its essential binding qualities.

Moreover, a straight run bitumen contains none of those chemical compounds present in other binders, such as phenol, cresol, naphthaline, etc., which are carried away by rain and contaminate streams even at a considerable distance.

Binders in which these chemicals are present actually rely upon them largely for their binding properties and, as they are subject to evaporation by the sun's heat as well as to the action of rain, it follows that their binding qualities gradually decrease to the point where they lose them altogether, and become so brittle as to crack and break up.

This also applies to a certain degree to those bitumens whose consistency has purposely been altered by the addition of cut-backs; this is done to lower the melting point of a hard grade of bitumen and, in some cases, with a view to reducing the cost of the product. The treatment of bitumen in this way, unless carried out with the greatest technical skill, is likely to have a damaging effect on the bitumen, both as regards its ductility and its durability.

The bitumen deposited by Colas is a pure straight-run bitumen, and therefore the most essential feature of the binder—ductility—is unimpaired.

To apply any binder hot necessitates the use of plant and fuel, the exercise of considerable skill and a possible delay for fine, dry weather.

THE SAFETY TEST

The Motor Racing Track at Linas Monthéry, outside Paris, was completed in May 1925, the Colas grouted surface being laid, despite severe weather conditions, at a lower cost and in shorter time than would have been possible by alternative methods. Proof that the Colas grouted road is ideal for the modern car is afforded by the testimony of such prominent motorists as Viscount Curzon, Major Segrave, Captain Malcolm Campbell, Monsieur Delage, the Hon. Mrs. Victor Bruce and others.

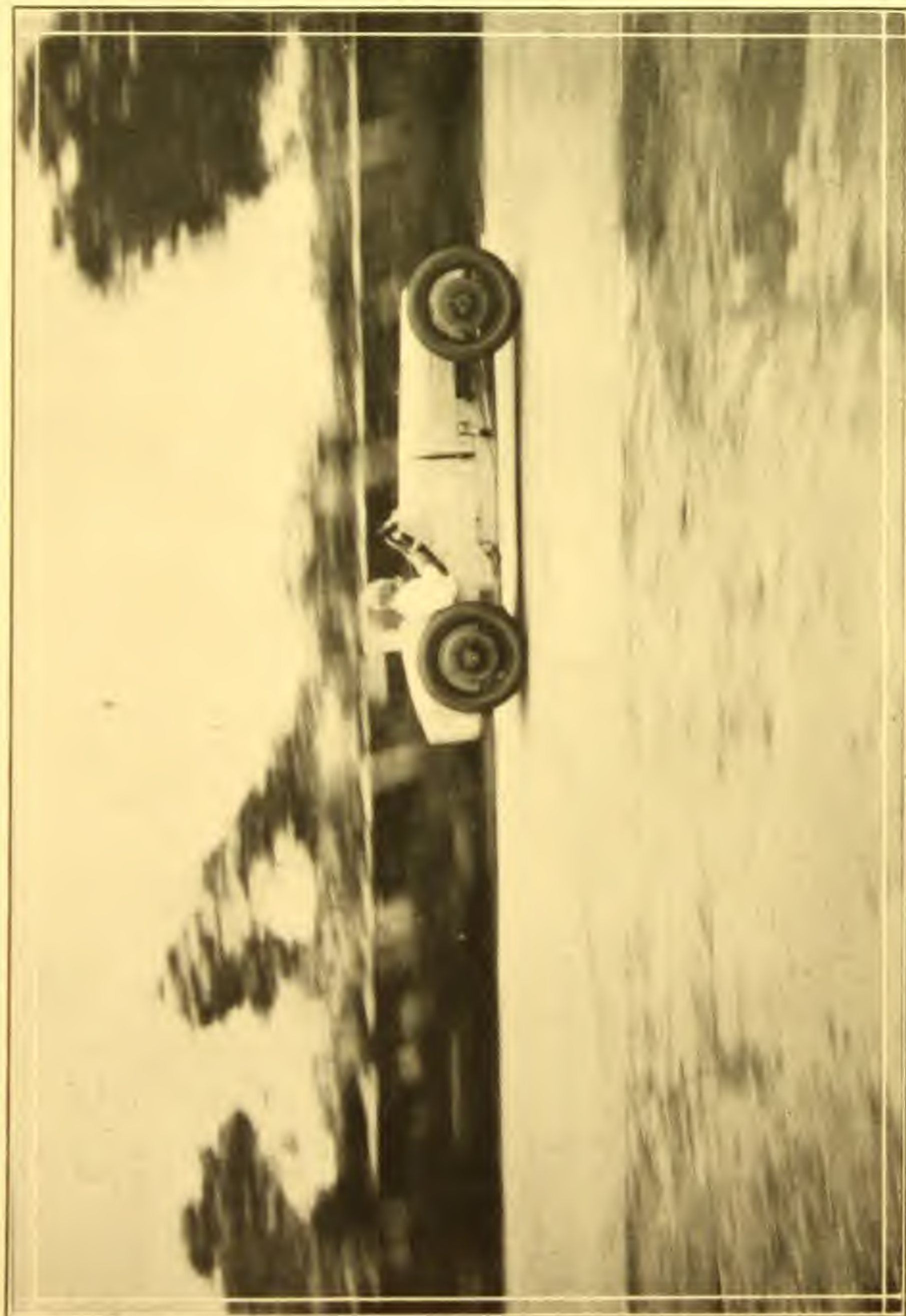


PLATE III



On the other hand, for the application of bitumen in the form of Colas no special plant or skill is required, while its use is favoured rather than hindered by damp weather conditions.

Colas is an emulsion of pure bitumen and water. The function of the water is simply that of a carrier—just as oil is the carrier of the pigment in paint.

*Action of
the Emul-
sion.*

When Colas is poured on the road, the water, acting as a carrier, takes the bitumen into and through the stone course. The bitumen precipitates, the water is thrown off and a film of pure bitumen is left on the stone.

Considerable stress has been laid on the necessity for a suitably graded aggregate, the physical interlocking of the stone, and the minimum percentage of voids. It may at first sight be thought, especially by those acquainted with the use of hot grouts, that these requirements are inconsistent with the successful application of a bitumen binder. With Colas no difficulty will be experienced, because where water will go Colas will penetrate. Therefore the reduction of voids in no way militates against the use of Colas.

*Full
Grout.*

The fluidity of the emulsion is sufficient to carry it down to the foundation of the road, and it is therefore obvious that the greater the depth of clean metal in the surfacing layer, the more binder will be required to cover all the stones. Thus a granite surface laid 4" thick and rolled to 3", will require 1½ to 2 gallons of Colas to the square yard for a "full grout."

The result will be a mosaic thoroughly bound throughout with bitumen, comparing favourably as regards not only strength, but cost, with a surface made

with a metal previously coated. Roads treated in this way with a full grout are capable of withstanding the wear of all modern traffic.

There are, however, a great number of roads which do not have to bear the same intensity of traffic as the main highways, yet the weights carried by them may be as heavy though less frequent.

Semi-Grout.

The old waterbound surface is not strong enough, yet the cost of a fully grouted road is probably not justified. To meet this case, the system of semi-grouting has been introduced with remarkably successful results.

Instead of grouting to the full depth of the surfacing material, the road is so constructed that the grout is prevented from penetrating deeper than the top layer of the stone course.

This is achieved by first spreading a layer $\frac{1}{2}$ " to $\frac{3}{4}$ " thick of sand, stone dust or hoggin on the old surface or foundation (if the old surface or foundation has been scarified, this is unnecessary). In addition to preventing the full penetration of the grout, this bed of hoggin or scarified material forms a filling and binder for the base of the new stone course.

The metal, which should be properly graded, is then spread to the requisite thickness, watered and rolled until the sand works up to within $\frac{3}{4}$ " to 1" of the finished surface. While still wet, the Colas is grouted in, using $\frac{3}{4}$ or 1 gallon per square yard. Owing to the interstices of the mosaic being filled with the sand up to $\frac{3}{4}$ " to 1" from the top, the Colas will only penetrate the top layer, yet the whole mosaic of the surfacing metal is one solid layer, the top portion with bitumen as binder being completely united with the lower waterbound portion.

After the application of the Colas, the surface is

covered with $\frac{1}{2}$ " chippings sufficient to fill up all the surface interstices, the road is then rolled, and finally sealed with a dressing of Colas after the traffic has been allowed to use the road for several days. The resulting road is fully equal to the requirements of a second-class road and far superior to the waterbound road surface-dressed with tar or bitumen.

Roads not strong enough during the winter months to hold up a roller to consolidate waterbound work can be treated with semi-grouting, provided that the subgrade, drainage and foundations of the existing road are adequate to the weight of traffic carried. In districts where a comparatively soft local stone is used, it will be found that, under the rolling necessary for semi-grouting, far less crushing takes place than in waterbound work. While stressing these advantages it is, however, very necessary to bear in mind that in Asphalt Macadam made by the penetration method and in semi-grouting, the metal of the road must be rolled *tight* and the foundation must be adequate if a successful result is to be obtained.

Rolling.

Chapter II

COLAS SURFACE DRESSING

THE development of the modern practice of surface dressing is to be traced back to the introduction of motor traffic. The passage of fast-moving vehicles with pneumatic tyres on the old waterbound roads caused a nuisance from the clouds of dust which followed. The effect of the fast-moving pneumatic-tyred vehicles was to suck out the smaller particles between the stones of the road surface, which in course of time resulted in a loosening of the whole surface.

Development of Modern Practice. Steps were first taken to dress the road surface with a dust laying medium. Watering proved inadequate, so tar was used. Tar was found to bind the top surface as well as laying the dust, thus preventing to some extent the disintegration of the road.

At the same time this dressing of tar was found to provide a waterproof covering, or seal, which protected the road from the effects of the weather. Surface dressing not only prevents dust, but waterproofs the road, and, in the case of waterbound roads, provides a binder to the metal of the top surface.

To protect the traffic it was necessary to cover, or 'blind,' this dressing with a coating of sand. The function of the sand was to prevent the tar from



THE FLOOD TEST

This photograph was taken immediately after a severe flood in Saxony ; the force of the flood was so great that it practically destroyed several villages and resulted in the deaths of over 100 people. The left half of the road is of ordinary waterbound construction which was surface dressed with Colas twelve months previously at the rate of 1 gallon to 3 sq. yds. The sett paving was unable to resist the force of the flood while the Colas surface was unharmed.



picking up and adhering to passing vehicles. Where for sand it is possible to substitute a layer of hard stone chippings, or crushed shingle, it is found that these will give new life to the top surface of the road, replacing, as it were, the metal lost by abrasion. Hard stone chippings are the best to use, though comparatively expensive, but even with crushed shingle the life of the road is definitely increased.

As explained in the chapter on asphalt macadam or grouted roads, the use of bitumen as a binder is in every way preferable to any other material.

The application of bitumen in a hot form for surface dressing presents similar difficulties and disadvantages as its application hot for grouting work. That is to say there is poor penetration, too sudden cooling and condensation of moisture, in addition to the necessity for elaborate plant, special technical skill, and the impossibility of working in any but fine weather.

Advantage of Cold over Hot Method.

The use, however, of a cold emulsion of bitumen in the form of Colas for surface dressing is both simple and effective. Moreover, with a cold emulsion for surface dressing, owing to its penetrative action, there is no necessity, as there is with hot applications, to brush the surfacing material into the surface.

The action of the Colas when it is used to dress or seal a road surface is similar to its action in grouting, but the extent of penetration will depend on the condition of the surface to be dressed.

Action of Colas.

Thus a newly-made waterbound road receiving a surface dressing for the first time will present an open or 'hungry' surface and will necessitate the use of about one-third to one-fourth of a gallon of Colas per square yard; whereas a road surface which has been

regularly dressed each year will present an almost completely waterproof surface, and the penetration will be practically nil, so that a satisfactory dressing of Colas can be applied at the rate of from 5 to 7 square yards to the gallon.

In the case of new waterbound roads the greater amount of Colas not only provides the top waterproofing coat, but will be found to have grouted to an appreciable depth the top surface of the waterbound road, thus strengthening this layer by the provision of a binder. The surface coat in this way becomes an integral part of the road itself.

Roads not previously treated with a surface dressing may give the impression that, after the first treatment with Colas, the surface dressing has disappeared. This is not the case however, and it will be found that the Colas has penetrated and is providing a binder in the top surface. The road will benefit by a second dressing after six months, when an excellent top finish will be obtained, which will last a full twelve months, or longer, according to the amount of traffic carried.

It is imperative, before commencing to dress a road, to free the surface thoroughly from dust and dirt by brushing, or even in bad cases by watering and scrubbing.

*Necessity
of Clean
Surface.*

Owing to the readiness with which the bitumen of the Colas is precipitated, the presence of dust on a road surface will prevent the bitumen from adhering to the stones; lumps of dust and bitumen will be formed which will not bind into the road.

It is advisable, before surface dressing, to repair all potholes and complete any patching that may be needed.

It is, of course, possible to do this afterwards, but practical experience indicates the desirability of previous treatment. The methods to be adopted in this repair work are detailed in Chapter IV.

The actual surface dressing with Colas is extremely simple, requiring a minimum of plant.

In the case of waterbound roads in dry weather, it is an advantage to dampen the surface with water immediately before applying the Colas, thereby obtaining a cleaner surface and better penetration. With tar macadam or previously dressed surfaces this is unnecessary.

*Methods
followed.*

To get satisfactory results, it is important to obtain as even a covering as possible, so the Colas is drawn smoothly over the surface with long bristled brooms or squeegees, care being taken to move the Colas as little as possible, only enough to get an even distribution.

Colas is also delivered in pressure tanks and applied to the road by air pressure, a system that gives absolutely even distribution and saves the cost of haulage and spreading. Full details are given in Chapter V.

The gritting must follow on immediately, the spreading of the grit being uniform and sufficient to cover the Colas without concealing it. It is essential that this operation should be completed before the Colas has had time to set.

The use of a road roller to follow up and consolidate the blinding is strongly recommended, as this helps materially in retaining the blinding in position.

To get the best results, the use of clean chippings or crushed shingle is strongly advocated, but where sand or grit containing much fines and dust is used for blinding, it should not be spread until the Colas has partially set. The reason is that the sand or other fine

particles sink through the unset Colas and defeat the real object of their use as blinding material.

As in the case of grouting, so also with surface dressing, the use of Colas for this class of work is not restricted to the summer months. Satisfactory results are obtained with Colas in winter when the use of hot materials is impossible.

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THE HEAT TEST

The illustration shows a road being treated with Colas in Ceylon. The grade of bitumen employed, combined with the evenness of its distribution in a thin film, makes Colas equally suitable for the heat of the Tropics and for the low temperatures of Northern climates.

Chapter III

RE-CONDITIONING ROADS WITH COLAS

THE problem of meeting the demands for road maintenance without exceeding the annual allotment of funds becomes more and more acute each year.

It is in this direction that Colas affords striking proof of its economical and efficient assistance. The timely use of Colas on roads that are showing serious signs of wear will enable these roads to be kept efficiently maintained for a period of years before complete resurfacing is necessary.

*Economy
and Efficiency of
Colas.*

Where the Colas remedy is applied a sound surface is obtained at a minimum cost involving only a small outlay in new metal. There are hundreds of miles of district roads in this country where this claim has been proved.

The Colas remedy will, of course, depend on circumstances. If the road is taken in hand at an early stage, the first step will be the repair of potholes with Colas and the application of a heavy surface dressing.

*First Colas
Remedy.*

The waterproof seal thus provided keeps out the wet from the road, and so guards against the disastrous effects of frost. If this first heavy surface dressing of

Colas is followed about six months later by a second dressing at the normal rate of distribution of 4-5 square yards to the gallon, and then by similar annual dressings, the life of the road is immensely prolonged. The only metal required for this Colas remedy are the chippings for the blinding of the surface dressing and for the pothole repairs.

Where the road surface has been allowed to develop potholes and ruts to such an extent that patching and ordinary repairs will not meet the case, the *Second Colas Remedy* only remedy that is too often considered is the complete resurfacing of the road, involving the purchase of perhaps as much as 1,000 cubic yards of metal per mile. This expense will frequently be found prohibitive, and, failing the solution by Colas methods, it is clear that the road will be left to go from bad to worse. This case, however, can be effectively and economically met, the procedure adopted being as follows :

The old road surface is first scarified throughout its length ; in extremely bad cases it may be advisable to screen the loose material, but as a general rule this is unnecessary. On top of the loosened surface, which must be reshaped to the required camber and levels, but not rolled, a new layer of 2" graded aggregate is spread to 'one stone thickness.' The whole is then lightly watered and rolled until firmly consolidated. A Colas semi-grout is applied at the rate of $\frac{3}{4}$ gallon of Colas per square yard, $\frac{1}{2}$ " chippings are then spread and rolled to fill the surface interstices, and after a few days a seal coat of Colas at the rate of 4 square yards per gallon is applied, which is blinded with $\frac{3}{8}$ " or $\frac{1}{4}$ " chippings and finally rolled again.

As in ordinary asphalt macadam work, the seal coat

is best not applied till after traffic has been allowed on the road for several days.

By these methods a new surface is provided at a minimum cost, the wearing properties of which are sufficient to enable the road to last out for some years before thorough resurfacing must be undertaken. *Summary.*

No surface will stand up to traffic unless the foundation of the road is sound. Therefore when re-conditioning roads it is important that the weak spots should be located and the suitable remedy applied, before the surface is renewed.

Chapter IV

PATCHING ROADS WITH COLAS

It is hardly necessary at this stage of progress in road maintenance to emphasize the advantages derived from systematic attention to the potholes of a road ; for the longer they are left unattended the greater will be the damage they cause to the road. Prompt repairs will defeat that worst enemy of the road engineer, the entrance of water into the body of the road.

The old-fashioned system, whereby hot tar or hot bitumen were used, entailed the dragging of a boiler from place to place, the delay due to heating, and the loss of time due to wet or bad weather. By the use of Colas all these disadvantages are overcome, and the repair of potholes can be effected throughout the twelve months, instead of being confined to six. Moreover, the repair is made so that no bump is left on the road surface, the patch ironing out to the existing road level. Owing to the qualities of the Colas, repairs effected with it do not bleed or push in summer, nor do they become brittle and glassy in winter. The system is applicable to potholes, cracks, trench fillings, water and wheel tracks in all kinds of road surfaces.

Details of the method to be pursued are given in the Specification on page 37.

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THE WEATHER TEST

This photograph illustrates two important advantages of Colas: its use in damp weather and its value as a non-slippery dressing. Note the slippery condition of the untreated surface in the foreground. The wet surface does not deter the action of the Colas, while the use of clean chippings, properly rolled in, provides an additional wearing coat that is perfectly non-slippery.



PLATE VI

Chapter V

THE COLAS TANK DELIVERY SERVICE

THE Colas Tank Delivery Service is an economic development brought about by the requirements of present-day road maintenance.

It is of value to the manufacturer as transportation in bulk is less costly, eliminating most of the expenses incurred with drums and their handling.

*An
Economic
Develop-
ment.*

It is also an economic development from the point of view of the customer. Instead of each Local Authority having to operate and maintain their own spraying equipment and to transport the materials to the site of the work, there is available an organisation that can deliver, and apply without extra charge, small or large quantities of Colas as and when required.

This Tank Delivery Service has now been in operation for some time, and the rapidly increasing demand on its services has caused it to grow to very considerable proportions.

The equipment comprises a lorry chassis on which is mounted a cylindrical tank of approximately 1,000 gallons capacity, an air compressor for supplying the spraying pressure and a bus-bar fitted with the spraying jets.

*The
Equip-
ment.*

The bus-bar is placed at the rear of the tank at a convenient height from the road to give maximum

spraying efficiency from the jets. There are nineteen jets on the standard bus-bar and each jet is controlled by a separate valve so that any jet may be closed or opened at will.

For normal spraying seven jets only are used (*i.e.* every third jet on the bus-bar is employed). For grouting all the jets are used.

The standard bus-bar will spray a strip 8 feet wide.

In order to treat efficiently roads of various widths, extension pieces are carried which can be connected to the standard bus-bar either on the near or the off side of the vehicle or both. By the addition of these extension pieces the widths of spray can be increased to 10 or 12 feet. All jets being individually controlled, one or more jets can be used for narrow strips. It will be seen, therefore, that any width of road can be treated without overlap.

*Controlling
Width of
Spray.*

An important feature is the fitting of two connections to the pressure tank to which are attached, by lengths of flexible tube, hand operated jets.

*Auxiliary
Hand-
operated
Jets.*

By means of these auxiliary jets it is possible to give extra treatment to weak portions of the road surface, to treat potholes and to spray odd sections of road such as occur at cross roads, road junctions or irregular widths. This hand treatment is accomplished as the Pressure Tank proceeds and without in anyway interrupting its straightforward work.

Those who have experienced the delays, manœuvring, overlapping and missed patches inseparable from the purely mechanical sprayer will at once appreciate the immense advantages of these auxiliary hand-operated jets.

The rate of distribution in super yards per gallon

of Colas is controlled definitely and accurately from the Pressure Tank in the following way :

The air pressure inside the tank is kept uniform throughout and each jet is calibrated and tested to give an accurate delivery of 4 gallons of Colas per minute. The rate of distribution can be controlled therefore by regulating the speed of the Tank Lorry. This is done by providing in the cab of the lorry a special speedometer graduated in gallons per yard as well as in miles per hour.

*Rate of
Applica-
tion.*

A check to the rate of application can be made quite readily by pacing for one minute alongside the tank ; the number of paces taken can be compared with the table given on page 60 which will give the required figure.

By these means any specified rate of application can be accurately carried out and checked.

On straightforward work the contents of a Pressure Tank, using the standard bus-bar, can be applied in 36 minutes. Making due allowance for stopping and turning, the whole time taken to apply a full load should not exceed 45 minutes.

*Daily
Surfacing
Capacity.*

With a gang of 10 to 15 men—depending upon the nature of the road surface, traffic or other local circumstances—and an adequate supply of chippings, no difficulty is experienced in applying up to 4,000 gallons of Colas in a working day.

Full advantage of the economies provided by a Pressure Tank can only be obtained by efficient organization of the gang for spreading the chippings.

One scheme which has been found highly satisfactory and simple in operation is to distribute the chippings in small heaps along the road side at intervals of about 3 yards. The

*Gang
Organiza-
tion.*

spreaders—preferably 10 to 15 in number—take up their positions at these heaps in the ratio of one man to four heaps of chippings. Immediately following the passage of the Pressure Tank each man distributes his four heaps of chippings and then moves forward successively to the head of the gang, where he again takes four heaps. In this way the work proceeds very quickly and without any confusion.

If the Pressure Tank gets too far ahead of the spreaders, it can be stopped at any time, as the whole range of jets can be instantly closed, thus allowing the spreading gang to keep abreast of the spraying work.

A few of the many types of mechanical gritters are suitable for use in conjunction with Pressure Tanks and under certain conditions their employment has some definite advantages. The *Mechanical Gritters.* Company is fully prepared to place the benefit of its experience with various types at the disposal of customers.

When working within road delivery radius of the Colas factories (approximately 40 miles) the Pressure Tank Lorries can be replenished on the site of the work from 1,000 gallon trailer tanks and from auxiliary tank lorries of the same capacity. *Radius of Operation.*

When operating at greater distances from the factories replenishment is effected from 3,000 gallon Rail Tank Cars, which are despatched to the nearest convenient sidings.

The transfer of a thousand gallons to the Pressure Tank from Rail Cars, trailer tanks or auxiliary tank lorries takes up to 30 minutes only, and is accomplished by utilizing the air pressure fittings of the Pressure Tank itself.

THE COLAS PRESSURE TANK

A Colas Pressure Tank in operation, showing the hand-operated jet for the treatment of weak places and portions of the road surface not accessible to the main jets. Note the chippings laid out in small heaps on the left side of the road.

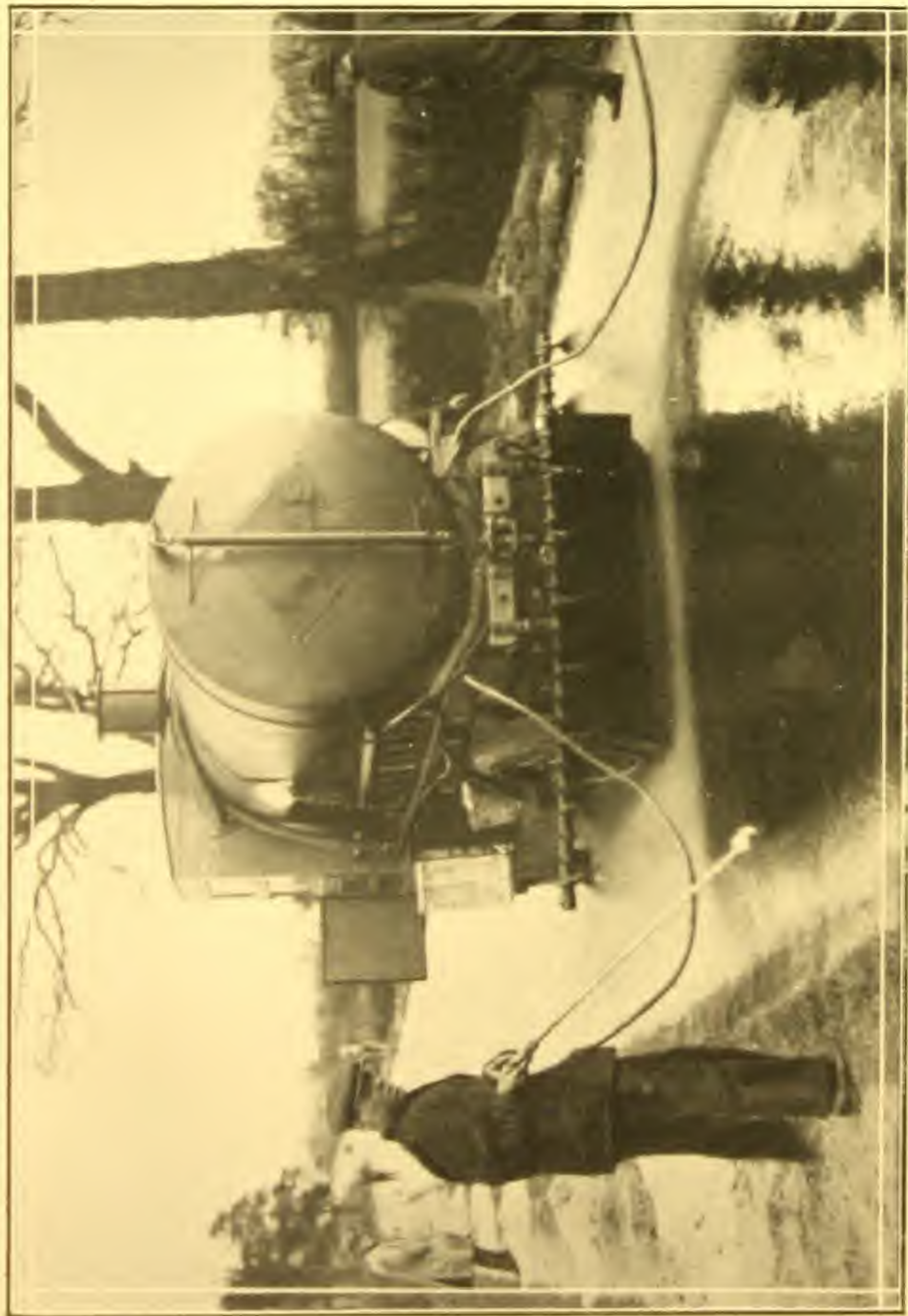


PLATE VII



To secure the benefit of this free 'delivery on the road' service, the minimum quantity of Colas to be purchased is only 1,000 gallons in the case of delivery taking place within road radius of one of the Colas factories, or 3,000 gallons in districts where delivery has to be made by rail tank car.

*Minimum
Quantities.*

Where requirements are below these minima, arrangements can nearly always be made with neighbouring buyers to take either a road tank or rail car load jointly.

Each Pressure Tank Lorry is operated by two men, a driver and his assistant. Both are specially trained, experienced men and are fully qualified to carry out their work efficiently. They will be found willing to assist in every way possible, and if consulted in regard to a plan of operation their experience will often enable them to offer suggestions of value.

Operators.

No charge is made for the Service, and there are no expenses whatever additional to the price per gallon paid for the Colas. The only stipulation made is that distribution is undertaken at a reasonable rate so that the Pressure Tanks may be worked efficiently.

*Free
Service.*

Instructions for work to be carried out should be communicated to the local Colas representative who will make immediate arrangements.

There can be no question but that the Colas Tank Delivery Service reduces costs to the purchaser and also ensures most economical and efficient application. The work is carried out absolutely uniformly, and the pressure at which the Colas is applied drives it well into the surface of the road.

Economy.

This method of delivery offers the following benefits to the purchaser :

Advantages.

1. It eliminates the cost of containers and the handling which these involve.
2. It eliminates haulage charges from station to roadside.
3. It enables even the smallest Local Authority to purchase Colas at an inclusive price 'delivered and applied to the road.'
4. It speeds up the rate of progress to an extraordinary degree and not only effects a considerable saving in labour costs, but reduces traffic delays very considerably.
5. It ensures more even and economical application than any other method and at the same time eliminates the disadvantages of entirely mechanical application.
6. It eliminates all waste of material—every gallon of Colas delivered is put upon the road surface.

Chapter VI

COLAS SERVICE

COLAS PRODUCTS LTD. and its Associated Companies have realised from the first that the success of a road material, however perfect it may be, is *Service.* dependent very largely upon the service that accompanies its sale. For this reason no expense has been spared in securing perfection in both manufacture and means of delivery, as well as in the building up of an efficient Service Organization able to give every possible assistance.

The whole country is divided up into districts of a convenient size, the Colas representative living at a central point in each. All the representatives have cars, and attached to them are experienced *Organiza-* foremen with motor-cycles. *tion.*

The advice and assistance of the Colas representatives or foremen are therefore always available at short notice. There is no obligation whatsoever involved in using this Service and we invite anyone to take advantage of it. Customers having gangs that are using Colas for the first time are earnestly requested to ask for the free assistance of a Colas foreman who will ensure that the work is carried out in the most satisfactory manner. The assistance given in this way has frequently been the means, not only of preventing

difficulties, but also of effecting a considerable saving of expense.

In Great Britain there are two fully equipped and specially constructed works, one at Silvertown, London, and the other at Ellesmere Port, on the Manchester Ship Canal. Both factories are capable of maintaining a very large output.

On the Continent and Overseas there are some twenty-three Colas factories and others are in course of erection.

A highly organized system of distribution enables consignments to be delivered in the shortest time.

Depots are established in convenient centres and in some cases these enable customers to make use of their own transport facilities, thereby making a saving in haulage costs.

Colas is delivered in bulk or in free, non-returnable steel drums.

The delivery of drums can be made by rail anywhere, or alternatively by road within 50 miles of our factories and within reasonable radius of our depots.

Delivery in bulk is made in 3,000 gallon rail cars or in 1,000 gallon road tanks, the contents of the rail tanks being transferred on arrival into road Pressure Tanks. Full details of the Colas Tank Delivery Service, by which application is undertaken without extra charge, are given in Chapter V.

By refilling old drums from a rail car at a convenient siding a saving of three-farthings to a penny a gallon can be effected. The Company loans a drum-filling outfit, packed in a special box, with the assistance of which a man and a boy can discharge the whole contents of a rail car in a few hours. If necessary, the Company can supply a strong, returnable drum for refilling

GROUTING I

The illustration shows in the foreground the layer of sand or stone dust upon which the new metal is being laid. If the foundation has been scarified and contains sufficient hoggin, this layer of fine material is unnecessary. Shovels, and not forks, are used for spreading the metal, in order to prevent the separation of the graded stone.



PLATE VIII



purposes, although the standard Colas container is usually found to be sufficient for this work.

The use of the steel container, combining reliability with cheapness to the greatest degree, was first introduced by the Company for the distribution of bitumen emulsion. In addition to being both light and sturdy the precision with which the drums are made ensures absolute accuracy of the amount of emulsion that each contains.

*Colas
Drums.*

A special broom is supplied for use with Colas, the price of which will be sent on application. The broom is made as light as possible to facilitate easy handling, the head and bristles being of the form that has been proved by experience to be the most suitable for spreading Colas on the road.

*Colas
Brooms.*

Pouring can baffles are supplied at a nominal charge; they are fitted to the spout of the ordinary 3 gallon pouring can.

*Pouring
Can
Baffles.*

There are various types of Drum Trucks and Hand Pressure Spraying Machines on the market concerning which the Company is always prepared to advise. A useful hand pressure spraying machine, capable of applying one drum at a time, is manufactured by Wallis and Steevens, Ltd., of Basingstoke, Hants.

*Drum
Trucks,
etc.*

Chapter VII

GENERAL SPECIFICATIONS

THE following specifications are submitted as a general basis for the use of Colas and have been prepared from actual experience. It is realized that local conditions and materials often vary, but where required the advice and assistance of our experienced road engineers are always available.

SPECIFICATION FOR ASPHALT MACADAM

Construction.—Fill all potholes and shape to the required contour. Then spread sand, hoggin or stone dust according to the proposed thickness of
(a) *Semi-Grouting.* the surface coat, for a 2" coat, say $\frac{1}{2}$ ", and for a 3" coat, say $\frac{3}{4}$ "; if the old surface or foundation has been scarified before laying the new material this will be unnecessary.

Aggregate.—To be graded 2" down to $\frac{3}{4}$ " in about the following proportions: 60% 2", 30% $1\frac{1}{2}$ ", 10% $\frac{3}{4}$ ". Care should be taken to preserve the proper grading of the aggregate throughout and for this purpose shovels should be used for spreading. One cubic yard of aggregate can be spread over 12 square yards to give a finished coat of 2" thickness.

The surface should then be watered and rolled, it being essential that the aggregate be tightly consolidated

before grouting is begun; considerably less water is required than in waterbound work, and the slurry should only be worked up to within $\frac{3}{4}$ " to 1" from the top.

Semi-Grouting.—When the surface is firm, and while the stone is still wet if possible, the Colas grout is applied either by the pressure tank lorry or by pouring from a watering can fitted with a special baffle in place of a rose.

With the pressure tank lorry an even distribution is obtained by regulating the pace of the lorry and making one or more trips over the surface to be treated, according to the strength of grout required. Full details are given in the table on page 60.

With the pouring can, the best method is for the operator to measure out the area of road surface to be grouted with one drum of Colas and to regulate the distribution accordingly. The first canful is poured on a longitudinal strip along the outside edge of the road. The remainder of the surface is then treated by pouring in longitudinal strips working from the middle of the road outwards. The operator must aim at an even distribution, avoiding excess of Colas in one place and too little in another.

As soon as a sufficient area has been treated and before the emulsion has had time to 'break,' $\frac{1}{2}$ " chippings are spread over the surface in sufficient quantity to fill up all surface interstices, but not in excess of this. The surface is then rolled to fix the chippings and on the following day is well rolled again. Careful and systematic rolling beginning at the haunches and finishing at the crown is essential.

The size and quantity of chippings will depend on the aggregate used; for example, with graded granite,

$\frac{1}{2}$ " chippings spread at the rate of 100 sq. yards per ton will be best.

Sealing Coat.—It is advisable to leave the grouted surface for some days, allowing the traffic to use it meanwhile, before applying the sealing coat.

The application of the sealing coat is effected in a manner similar to the grouting but only $\frac{1}{4}$ gallon of Colas is required per square yard, and the operator with the pouring can must move more quickly. After the Colas is applied, and before the emulsion 'breaks,' the final gritting with $\frac{3}{8}$ " chippings or crushed shingle is spread evenly over the surface at the rate of 160 square yards per ton, and the finished surface well rolled.

The instructions for the semi-grouting method apply to full grouting in all details except that the amount of water to be used in the construction of the
(b) *Full Grouting.* road surface will be considerably less for a full grout of $1\frac{1}{2}$ to 2 gallons of Colas per square yard.

The quantity of Colas used depends on the extent to which the bottom slurry is worked up. For a full grout of 2 gallons the surface should be dry rolled till firm and solid, the sand or stone dust acting as a seal to the bottom of the stone course; if $1\frac{1}{2}$ gallons per square yard are applied, only sufficient water is used to bring the slurry to within $1\frac{1}{2}$ " from the top by the time that the surface is consolidated by rolling. The quantity of Colas used thus depends on the extent to which the bottom slurry is worked up.

General Remarks.—In using these methods it is not necessary to close half the road to traffic; the spreading and rolling can be carried out over the full width, but during the actual operation of pouring the Colas on the road it is advisable to keep traffic to the half of the road

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GROUTING II

A longitudinal strip is first grouted down one edge of the road and the grouting is then continued by beginning at the centre of the road and working towards the channel. Immediately after grouting the surface is "racked up" with sufficient chip-pings to fill the surface interstices and rolled.

not actually being treated at the moment. Traffic may be allowed to pass over the Colas treated surface immediately after the chippings are applied and rolled, either at the grouting or at the sealing stage of the work. It is essential for the surface to be properly cleaned before the sealing coat is applied.

SPECIFICATION FOR SURFACE DRESSING

All potholes must be repaired in advance. Before the application of the Colas, the road must be swept thoroughly clean by fibre brooms to clean off all dust and dirt. It may be found expedient to wash the road and scrub out mud that has caked on the surface, steel wire brooms with short bristles being used ; this should, however, only be necessary in the case of very dirty roads. Colas applied to a dirty road will not penetrate the top skin of the road surface and will flake off ; therefore preliminary cleansing is essential.

*Prepara-
tory
Work.*

After the road is properly clean, the Colas should be applied by one of the following methods :

*Colas
Dressing.*

1. By means of the Colas Pressure Tank Lorry, in which case an even and regular distribution is automatically obtained, and no labour is required for spreading the Colas.
2. By means of buckets or pouring cans, filled from the drum, the Colas being poured on to the road, or
3. Direct from the drum on to the road, either with or without the aid of the various drum trucks and hand pressure machines that are available for this work.

If either a broom or squeegee is used (special types are recommended for Colas work) the action of spreading Colas must be carefully done by even movements in one direction only and not by pushing to and fro ; this ensures even distribution and avoids any tendency to disturb the setting of the emulsion. If the road is very dry, it is an advantage to dampen the surface by a light application of water from an ordinary watering cart as a preliminary to the Colas dressing.

Before the emulsion has had time to break, the surface is covered with a layer of chippings or crushed shingle. The chippings must be evenly spread, the thickness of the layer being not so great as will prevent the penetration of air to the Colas. It is found in practice that to satisfy this requirement and at the same time to give an adequate protection to the road surface, 1 ton of $\frac{3}{8}$ " chippings should be made to cover from 150 to 180 square yards.

The size of chippings used should correspond to the rate of application of the Colas and, to some extent, to the nature of the surface treated. Thus on new waterbound work dressed at 3 to 4 square yards per gallon, $\frac{1}{2}$ ", $\frac{5}{8}$ " or even $\frac{3}{4}$ " chippings can be used with advantage ; on previously treated surfaces sprayed at 5 to 7 square yards per gallon, the chippings should be $\frac{1}{2}$ " to $\frac{3}{8}$ ".

The road can be used by traffic immediately after gritting.

In all cases it is strongly recommended that the gritting should be closely followed up by a road roller which will help to fix the blinding material firmly in the Colas and thus ensure the non-slip feature of the dressing.

SPECIFICATION FOR PATCHING AND
REPAIRS

All portions of the surface to be repaired must be thoroughly cleaned ; all loose material, dirt or dust must be removed. In the case of waterbound surfaces it may even be necessary to dampen the surface and to scour it with a hard broom to get it clean. (Water does not prevent Colas from adhering to road surfaces.)

*Prelimin-
ary
Cleaning.*

The pothole, wheel track, etc., must be filled with properly graded aggregate. The size of the stone will depend on the depth of the repair ; thus for a hole 2" deep, stone graded from $1\frac{1}{2}$ " to $\frac{1}{2}$ " should be used. The stone is rolled or rammed and Colas is then poured over it in sufficient quantity to coat the aggregate ; the patch is then blinded with chippings and again rolled or rammed.

*Applica-
tion of
Colas.*

In the case of shallow depressions, after cleaning, paint fairly heavily with Colas, cover with chippings of suitable size, and well roll or ram.

Note.—The aggregate and chippings must be quite clean and free from dust or dirt.

Chapter VIII

OTHER SPECIFICATIONS

FLINT AND GRAVEL GROUTING

MANY miles of flint grouted surfaces are giving highly satisfactory service in districts where flints are available as local aggregate.

Field picked flints or local gravel, often costing under 10/- per cubic yard delivered on site, offer a decidedly economical aggregate when grouted and surface sealed with Colas.

An asphalt macadam surface capable of carrying heavy traffic can be produced in the following way :

The old surface of the road is scarified to a depth of 2", raked to contour, and any weak places are strengthened. The flints, graded from $2\frac{1}{2}$ " down to $\frac{3}{4}$ ", are laid 3" thick on this scarified bed. Water is applied in the ordinary manner, rolling and consolidating takes place, and during this operation the fine material from the scarified base is worked up to within one inch of the surface.

The emulsion is applied by a pouring can and baffle evenly over the surface at the rate of $\frac{3}{4}$ of a gallon to the square yard, covered by a light coating of $\frac{5}{8}$ in. shingle at the rate of 160 super yards to the cubic yard, and well rolled.

After the surface has been carrying traffic for a few days, a sealing coat is applied at the rate of a quarter of

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SURFACE DRESSING WITH BUCKET AND BROOM

The Colas is poured on to the surface with a bucket and spread evenly over the road by drawing it out with a broom.



a gallon to the yard super, blinded with $\frac{3}{8}$ " crushed shingle at the rate of 160 square yards to the ton, and lightly rolled.

THE SURFACE DRESSING OF WOOD PAVING

The ordinary routine is followed except that experience has shown that either clean $\frac{1}{4}$ " granite chippings or $\frac{3}{8}$ " crushed shingle provide the best blinding material. It is not, however, advisable to treat wood blocks when they are saturated with water.

Newly laid wood blocks should not be treated with Colas as the creosote present in the blocks acts as a flux to the bitumen and increases its penetration point beyond a safe margin in warm weather. Treatment with Colas can, however, be carried out after the surface has been under wear for a few months.

STEEP GRADIENTS

Provided that it is maintained in good condition the ordinary waterbound road provides a very safe surface for steep gradients. As modern traffic and the high cost of maintenance render this form of construction no longer suitable, it is necessary for the aggregate to be more permanently bound without, however, impairing its non-slippery features.

How successful Colas has been for the grouting of steep and difficult gradients is proved by its very extensive use for this type of work. Gradients of 1 in 6, and even steeper, have been provided with surfaces that give an excellent foothold for all types of traffic.

In normal circumstances the usual Colas grouting specification is followed, and it is found that the best results are obtained with aggregate graded from 2" to $\frac{3}{4}$ ".

It is recommended that the stone should be partially slurried from the base up as explained on page 32 and then grouted with Colas at the rate of $1\frac{1}{4}$ to $1\frac{1}{2}$ gallons per square yard, and blinded off with $\frac{3}{8}$ " or $\frac{1}{2}$ " chippings which should be well rolled into position. After a few days' traffic, the resultant surface is a mosaic in which the stone shows up slightly 'proud.' This gives an excellent foothold for horses, and yet the aggregate is bound sufficiently close to stand up successfully to fast and heavy motor traffic.

If, at a later date, it should be found necessary to apply a sealing coat, it is often the practice on very steep hills to leave unsealed a longitudinal strip, some eighteen inches in width, a few feet from the channel on each side of the road; this provision is much appreciated by horse owners.

SURFACING STONE SETT PAVING

In many towns sett paving is no longer found so suitable as hitherto; modern requirements demand quieter and more hygienic surfaces. The following method of treatment has been extensively adopted with very satisfactory results. It is especially suitable for resurfacing badly worn paving, of which the cost of replacement is practically prohibitive; by imposing a Colas wearing coat on the setts a durable surface is provided upon a very solid foundation.

The paving should be thoroughly cleaned and the interstices scraped out with a sharp instrument. If possible the interstices should be cleaned to a depth that is at least equal to the width between the setts. If very dirty, the setts should be washed down and scrubbed.

*Method of
Treat-
ment.*

The interstices should then be filled with hardstone chippings of a suitable size and grouted in with Colas, care being taken to ram the chippings well in between the setts. This work and also any patching required to bring depressions up to the general level of the road surface should be carried out a day or two before the surface dressing of the whole.

The surface should then be dressed with Colas at, approximately, 6 sq. yds. to the gallon and blinded off with a heavy coating (about $\frac{1}{4}$ " to $\frac{1}{2}$ " thick) of $\frac{1}{4}$ " to $\frac{3}{8}$ " chippings. Upon this layer of small chippings there should then be laid a carpet of larger size stone (graded either $\frac{1}{2}$ ", $\frac{3}{4}$ " or $1\frac{1}{4}$ ", in accordance with the thickness of carpet required), care being taken to see that the surface voids are neither excessive in quantity nor large in size. After this carpet has been well rolled, the surface should be grouted with Colas at a rate in accordance with the thickness of carpet, *i.e.*, $\frac{3}{4}$ gallon for a 1" carpet and 1 gallon per sq. yd. for $1\frac{1}{2}$ " carpet. The surface should then be blinded off with $\frac{3}{8}$ " chippings and again rolled. After the road has been opened to traffic for a few days a surface dressing at 4 sq. yds. to the gallon should be applied and blinded off with $\frac{3}{8}$ " chippings.

*Applica-
tion of
Colas.*

It may be thought that this treatment gives a surface that is more prone to become slippery than the original sett paving, but, provided that a stone of hard quality is used, this specification can be safely adopted even on steep gradients where horse traffic predominates. It is, in fact, contended by some surveyors that, as the colassed dressing gives a more level road and therefore a larger bearing surface for the shoe of the horse, it gives a better foothold than the more irregular pavement provided by stone setts.

*Non-skid
Surface.*

A TOPPING FOR NEW TARMACADAM

New tarmacadam can be sealed by the following method at a lower cost and with better results than are usually obtained when fine tarmacadam toppings are used for this purpose.

After ensuring that the surface is clean, sufficient chippings are spread over the road to fill the surface interstices. The chippings should be lightly brushed over the road with a broom so that only those chippings that are lying in the interstices are left upon the surface.

Method of Treatment.

The size of the chippings is important and they should be of one grading only. For $1\frac{1}{2}$ " tarmacadam a $\frac{1}{2}$ " chipping is usually the most suitable and for a larger size of tarmacadam $\frac{3}{4}$ " chippings should be used.

The road should then be rolled to embed the clean chippings firmly into the voids. The Colas is applied as evenly as possible from a pouring can fitted with a baffle (as described on page 32), application at four square yards to one gallon usually being sufficient. After the surface has been blinded with $\frac{3}{8}$ " chippings and again rolled, it can be opened to traffic.

Several important advantages are claimed for this method of treatment. In the first place there is a general tendency for mixed tarmacadam toppings to contain an excess quantity of binder which results in movement and bleeding in hot weather; by using clean chippings which are bound with only a sufficiency of pure bitumen with a high melting point, the road is unaffected by hot weather.

Advantages.

Secondly, the use of a properly graded chipping to fill the interstices of the new tarmacadam results

THE PRESER- VATION OF WOOD PAVING

A view of High Holborn
the wood paved surface of
which has been preserved
with Colas.

Colas is eminently suitable
for the treatment of heavily
trafficked streets. It is
applied very quickly and
traffic can pass over the
dressing immediately, as
Colas does not pick up or
damage paintwork.



PLATE XI



in a more tightly compacted surface than is the case with fine tarmacadam toppings.

Lastly, the Colas method can be carried out at a lower cost.

PLAYGROUNDS

The increasing number of County Architects and Educational Authorities specifying the use of Colas for the treatment of playgrounds and other surfaces bearing constant wear affords proof of its suitability for work of this kind.

One of the principal reasons for the extensive use of Colas for the surfacing of playgrounds is the extreme simplicity of its application.

By the Colas method a durable and resilient surface is obtained, using a binding material of pure bitumen with no harmful ingredients: an important consideration where children are always liable to falls and cuts.

As no plant or technical experience is necessary, the work can be carried out at a low cost by local labour or local contractors. A further advantage is that the work can equally well be carried out during the term time. A good result is guaranteed if full advantage is taken of the Company's facilities for giving free advice and assistance.

The following specifications are given as a general basis upon which the work can be carried out, and it is found from experience that these methods give the best results. It is realized that local conditions and materials often vary, but when it is necessary to depart in any respect from the following methods it is particularly requested that the advice of the Colas representatives or foremen be

*Methods of
Treatment.*

sought. There is no charge or obligation for this assistance, as it is in our interests as much as our customers' that the very best results should be obtained.

The foundation must be firm, formed to the correct levels, and must be free from any clay. The gravel or other clean local stone for the surfacing layer should be graded from 2" to $\frac{3}{4}$ " and must be clean and sharp, without too large a proportion of round pebbles. It must contain not less than 25 per cent. and not more than 50 per cent. of sand (not containing more than 10 per cent. of loam).

*Colas
Dressed
Gravel
Play-
grounds.*

The stone must be spread over the surface evenly, watered and rolled until the slurry works up to the surface. All surplus slurry must be swept off so as to leave the surface with the top stones clean and firmly held. After the surface has practically dried out it should be swept again before applying Colas.

The Colas should be applied evenly at the rate of approximately 3 square yards to the gallon and immediately blinded with a mixture of $\frac{3}{8}$ " clean crushed shingle and sand in equal proportions or with $\frac{3}{8}$ " limestone chippings, the surface being rolled as soon as the dressing has been covered. It should be noted that the spreading of the Colas must be done evenly by means of brooms, the action of spreading being done by drawing the broom in one direction only and not by pushing to and fro. If the surface is very dry it is an advantage to dampen it by a light application of water as a preliminary to the Colas dressing. The use of a 15 cwt. roller is recommended.

A further dressing of Colas should be applied after two or three weeks, the surface being blinded with sand or stone dust and rolled as before.

Old waterbound surfaces that are thoroughly consolidated are eminently suitable for treatment with Colas.

The surface should conform to the correct contour to permit surface water drainage and should be swept perfectly clean of all dirt and loose material. The application of Colas by the method described above will then furnish a waterproof seal to the surface, thereby giving it a considerably longer life.

Surfaces that have been previously treated with tar or have been paved with tar-macadam will be improved and given a new lease of life by a dressing of Colas.

Any depressions or potholes should first be made good. Large holes should be thoroughly cleaned and filled with stone graded according to depth. After grouting with Colas, using sufficient to ensure that each stone is well coated, the repair should be covered with $\frac{3}{8}$ " chippings and well rolled or rammed. Shallow depressions should be cleaned, painted heavily with Colas, covered with chippings of suitable size and rolled.

A dressing of Colas at the rate of from 4 to 6 square yards to the gallon, according to the condition of the surface, should then be applied, the method being the same as described above.

This treatment will effectively renew a worn or broken surface.

FOOTPATHS

Very good results can be obtained at low cost by using Colas for surfacing footpaths. It can be used on furnace clinker, gravel, limestone, slag, granite or other suitable aggregate.

Form foundation of the larger material and thoroughly roll. Spread a suitable material, size $\frac{1}{2}$ " to $\frac{1}{4}$ ", to a thickness of about 1 inch and water and
Construction. roll until thoroughly consolidated, shaping as required. The Colas should then be applied at the rate of about $\frac{3}{4}$ gallon to one superficial yard, gritted with $\frac{1}{4}$ " clean chippings and again rolled.

Before applying the sealing coat, the footpaths should, if possible, be subjected to wear for a few days. After being swept an application of
Sealing Coat. Colas should be made at the rate of one gallon to four superficial yards, lightly covered with $\frac{1}{4}$ " to dust chippings and rolled.

Repairs can be carried out in a similar manner to those described for roads, but the aggregate
Repairs. should be much smaller.

A STEEP HILL

The Main Street of Grange-over-Sands has an average gradient of 1 in 9. The surface has been constructed with graded granite semi-grouted with Colas, using 1 gallon to the square yard, including sealing coat. The cost of the work was 2s. 6d. per square yard inclusive, and no maintenance work had been necessary up to the time this photograph was taken three years later. The road carries heavy traffic and the surface is perfectly safe for horses.



PLATE XII



Appendix

ANALYSES OF COSTS

THE following Analyses of Costs have been prepared in detail with a view to furnishing data of materials required and man-hours of work done ; the prices given need to be amended in each case to suit local conditions.

Thus it may be found that the graded aggregate can be supplied at, say, 16/- per ton instead of 18/-, and that the spreading can be done at an increased rate. It is hoped, however, that the following tables will furnish sufficient data to enable each case to be analysed easily.

(1) GRANITE AND FULL GROUT OF
COLAS

MATERIALS.

COST PER Y.S.
s. d.

2" to $\frac{3}{4}$ " graded granite at 8 y.s. per ton delivered at site at, say, 18/- per ton -	2	3
*Stone dust for bottoming at 60 y.s. per ton delivered at site at, say, 9/- per ton -	0	1·8
$\frac{1}{2}$ " granite chippings at 100 y.s. per ton delivered at site at, say, 19/3 per ton -	0	2·3
$\frac{1}{4}$ " granite chippings at 160 y.s. per ton delivered at site at, say, 20/3 per ton -	0	1·5
Colas for grouting at $1\frac{3}{4}$ gals. per y.s. at 10d. per gal. including cartage -	1	5·5
Colas for sealing coat at $\frac{1}{4}$ gal. per y.s. -	0	2·5

LABOUR.

Spreading at rate of 400 y.s. per day per gang of 1 ganger and 6 men -	0	1·7
Grouting and spreading $\frac{1}{2}$ " granite chippings, 400 y.s. per 20 man-hours -	0	0·6
Sealing and spreading $\frac{1}{4}$ " chippings at rate of 400 y.s. per 10 man-hours -	0	0·3

ROLLER.

1 Roller at 4/6 per hour including driver and fuel, rolling 400 y.s. per day -	0	1·1
TOTAL - - -	4	8·3

Say - - 4s. 8 $\frac{1}{2}$ d.

* This is unnecessary if the new metal is spread upon a scarified surface already containing a percentage of hoggin.

(2) GRANITE AND SEMI-GROUT OF COLAS

MATERIALS.

COST PER Y.S.
s. d.

2" to $\frac{3}{4}$ " graded granite at 10 y.s. per ton delivered at site at, say, 18/- per ton -	1	9.6
*Hoggin for slurry at 50 y.s. per ton delivered at site at, say, 8/- per ton -	0	1.9
$\frac{1}{2}$ " granite chippings at 100 y.s. per ton delivered at site at, say, 19/3 per ton -	0	2.3
$\frac{3}{8}$ " crushed shingle at 160 y.s. per cu. yd. delivered at site at, say, 10/6 per cu. yd.	0	0.8
Colas for grouting at $\frac{3}{4}$ gal. per y.s. at 10d. per gal. including cartage - - -	0	7.5
Colas for sealing at $\frac{1}{4}$ gal. per y.s. - - -	0	2.5

LABOUR.

Spreading hoggin and granite at rate of 500 y.s. per gang of 1 ganger and 8 men	0	1.8
Grouting and spreading $\frac{1}{2}$ " granite at 500 y.s. per 20 man-hours - - -	0	0.5
Sealing and spreading $\frac{3}{8}$ " shingle at 500 y.s. per 10 man-hours - - -	0	0.2

ROLLER.

One Roller at 4/6 per hour, including driver and fuel, rolling 500 y.s. per day - -	0	0.8
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 TOTAL - - 3 3.9

Say - - 3s. 4d.

* This is unnecessary if the new metal is spread upon a scarified surface already containing a percentage of hoggin.



AREAS IN SQUARE YARDS

Width Feet.	LENGTH.								
	100 Yds.	$\frac{1}{8}$ th Mile 176 Yds.	$\frac{1}{4}$ Mile 352 Yds.	$\frac{3}{8}$ Mile 528 Yds.	1 Mile.	2 Miles.	3 Miles.	4 Miles.	5 Miles.
2	66 $\frac{2}{3}$	117 $\frac{1}{2}$	586 $\frac{2}{3}$	880	1,173 $\frac{1}{2}$	2,346 $\frac{2}{3}$	3,520	4,693 $\frac{1}{2}$	5,866 $\frac{2}{3}$
3	100	176	880	1,320	1,760	3,520	5,280	7,040	8,800
4	133 $\frac{1}{2}$	234 $\frac{2}{3}$	1,173 $\frac{1}{2}$	1,760	2,346 $\frac{2}{3}$	4,693 $\frac{1}{2}$	7,040	9,386 $\frac{2}{3}$	11,733 $\frac{1}{2}$
5	166 $\frac{2}{3}$	293 $\frac{1}{2}$	1,466 $\frac{2}{3}$	2,200	2,933 $\frac{1}{2}$	5,866 $\frac{2}{3}$	8,800	11,733 $\frac{1}{2}$	14,666 $\frac{2}{3}$
6	200	352	1,760	2,640	3,520	7,040	10,560	14,080	17,600
7	233 $\frac{1}{2}$	410 $\frac{2}{3}$	2,053 $\frac{1}{2}$	3,080	4,106 $\frac{2}{3}$	8,213 $\frac{1}{2}$	12,320	16,426 $\frac{2}{3}$	20,533 $\frac{1}{2}$
8	266 $\frac{2}{3}$	469 $\frac{1}{2}$	2,346 $\frac{2}{3}$	3,520	4,693 $\frac{1}{2}$	9,386 $\frac{2}{3}$	14,080	18,773 $\frac{1}{2}$	23,466 $\frac{2}{3}$
9	300	528	2,640	3,960	5,280	10,560	15,840	21,120	26,400
10	333 $\frac{1}{2}$	586 $\frac{2}{3}$	2,933 $\frac{1}{2}$	4,400	5,866 $\frac{2}{3}$	11,733 $\frac{1}{2}$	17,600	23,466 $\frac{2}{3}$	29,333 $\frac{1}{2}$
11	366 $\frac{2}{3}$	645 $\frac{1}{2}$	3,226 $\frac{2}{3}$	4,840	6,453 $\frac{1}{2}$	12,906 $\frac{2}{3}$	19,360	25,813 $\frac{1}{2}$	32,266 $\frac{2}{3}$
12	400	704	3,520	5,280	7,040	14,080	21,120	28,160	35,200
13	433 $\frac{1}{2}$	762 $\frac{2}{3}$	3,813 $\frac{1}{2}$	5,720	7,626 $\frac{2}{3}$	15,253 $\frac{1}{2}$	22,880	30,506 $\frac{2}{3}$	38,133 $\frac{1}{2}$
14	466 $\frac{2}{3}$	821 $\frac{1}{2}$	4,106 $\frac{2}{3}$	6,160	8,213 $\frac{1}{2}$	16,426 $\frac{2}{3}$	24,640	32,853 $\frac{1}{2}$	41,066 $\frac{2}{3}$
15	500	880	4,400	6,600	8,800	17,600	26,400	35,200	44,000
16	533 $\frac{1}{2}$	938 $\frac{2}{3}$	4,693 $\frac{1}{2}$	7,040	9,386 $\frac{2}{3}$	18,773 $\frac{1}{2}$	28,160	37,546 $\frac{2}{3}$	46,933 $\frac{1}{2}$
17	566 $\frac{2}{3}$	997 $\frac{1}{2}$	4,986 $\frac{2}{3}$	7,480	9,973 $\frac{1}{2}$	19,946 $\frac{2}{3}$	29,920	39,893 $\frac{1}{2}$	49,866 $\frac{2}{3}$
18	600	1,056	5,280	7,920	10,560	21,120	31,680	42,240	52,800
19	633 $\frac{1}{2}$	1,114 $\frac{2}{3}$	5,573 $\frac{1}{2}$	8,360	11,146 $\frac{2}{3}$	22,293 $\frac{1}{2}$	33,440	44,586 $\frac{2}{3}$	55,733 $\frac{1}{2}$
20	666 $\frac{2}{3}$	1,173 $\frac{1}{2}$	5,866 $\frac{2}{3}$	8,800	11,733 $\frac{1}{2}$	23,466 $\frac{2}{3}$	35,200	46,933 $\frac{1}{2}$	58,666 $\frac{2}{3}$
21	700	1,232	6,160	9,240	12,320	24,640	36,960	49,280	61,600
22	733 $\frac{1}{2}$	1,290 $\frac{2}{3}$	6,453 $\frac{1}{2}$	9,680	12,906 $\frac{2}{3}$	25,813 $\frac{1}{2}$	38,720	51,626 $\frac{2}{3}$	64,533 $\frac{1}{2}$
23	766 $\frac{2}{3}$	1,349 $\frac{1}{2}$	6,746 $\frac{2}{3}$	10,120	13,493 $\frac{1}{2}$	26,986 $\frac{2}{3}$	40,480	53,973 $\frac{1}{2}$	67,466 $\frac{2}{3}$
24	800	1,408	7,040	10,560	14,080	28,160	42,240	56,320	70,400
25	833 $\frac{1}{2}$	1,466 $\frac{2}{3}$	7,333 $\frac{1}{2}$	11,000	14,666 $\frac{2}{3}$	29,333 $\frac{1}{2}$	44,000	58,666 $\frac{2}{3}$	73,333 $\frac{1}{2}$
26	866 $\frac{2}{3}$	1,525 $\frac{1}{2}$	7,626 $\frac{2}{3}$	11,440	15,253 $\frac{1}{2}$	30,506 $\frac{2}{3}$	45,760	61,013 $\frac{1}{2}$	76,266 $\frac{2}{3}$
27	900	1,584	7,920	11,880	15,840	31,680	47,520	63,360	79,200
28	933 $\frac{1}{2}$	1,642 $\frac{2}{3}$	8,213 $\frac{1}{2}$	12,320	16,426 $\frac{2}{3}$	32,853 $\frac{1}{2}$	49,280	65,706 $\frac{2}{3}$	82,133 $\frac{1}{2}$
29	966 $\frac{2}{3}$	1,701 $\frac{1}{2}$	8,506 $\frac{2}{3}$	12,760	17,013 $\frac{1}{2}$	34,026 $\frac{2}{3}$	51,040	68,053 $\frac{1}{2}$	85,066 $\frac{2}{3}$
30	1,000	1,760	8,800	13,200	17,600	35,200	52,800	70,400	88,000

QUANTITIES PER MILE OF ROAD

Width (Feet).	Sq. Yds.	TONS OF METAL AT PER TON.			
		8 Sq. Yards.	10 Sq. Yards.	12 Sq. Yards.	15 Sq. Yards.
2	1,173	147	117	97	78
3	1,760	220	176	147	117
4	2,346	294	235	196	157
5	2,933	367	293	244	196
6	3,520	440	352	293	235
7	4,106	514	411	342	274
8	4,693	587	469	391	313
9	5,280	660	528	440	372
10	5,897	737	590	491	393
12	7,040	880	704	587	470
14	8,213	1,027	821	684	548
15	8,800	1,100	880	733	587
16	9,387	1,173	939	782	624
18	10,560	1,320	1,056	880	704
20	11,733	1,466	1,173	978	782
22	12,907	1,613	1,291	1,076	860
24	14,080	1,760	1,408	1,175	939
26	15,253	1,907	1,525	1,271	1,017
28	16,427	2,053	1,643	1,369	1,095
30	17,600	2,200	1,760	1,467	1,173

VOLUMES

CUBIC YARDS PER MILE

Width (Feet).	Thickness (Inches).	Cubic Yards.
9	2	293
9	$2\frac{1}{2}$	367
9	3	440
9	4	587
15	2	489
15	$2\frac{1}{2}$	611
15	3	733
15	4	978
16	2	522
16	$2\frac{1}{2}$	652
16	3	782
16	4	1,043
20	2	652
20	$2\frac{1}{2}$	815
20	3	978
20	4	1,304

GROUTING WORK TABLE OF GALLONS REQUIRED

Width of Roadway in Feet.	PER 100 YDS. OF LENGTH.						
	Gallons per Square Yard.						
	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2
2	33 $\frac{1}{2}$	50	66 $\frac{2}{3}$	83 $\frac{1}{3}$	100	116 $\frac{2}{3}$	133 $\frac{1}{3}$
3	50	75	100	125	150	175	200
4	66 $\frac{2}{3}$	100	133 $\frac{1}{3}$	166 $\frac{2}{3}$	200	233 $\frac{1}{3}$	266 $\frac{2}{3}$
5	83 $\frac{1}{3}$	125	166 $\frac{2}{3}$	208 $\frac{1}{3}$	250	291 $\frac{2}{3}$	333 $\frac{1}{3}$
6	100	150	200	250	300	350	400
7	116 $\frac{2}{3}$	175	233 $\frac{1}{3}$	291 $\frac{2}{3}$	350	408 $\frac{1}{3}$	466 $\frac{2}{3}$
8	133 $\frac{1}{3}$	200	266 $\frac{2}{3}$	333 $\frac{1}{3}$	400	466 $\frac{2}{3}$	533 $\frac{1}{3}$
9	150	225	300	375	450	525	600
10	166 $\frac{2}{3}$	250	333 $\frac{1}{3}$	416 $\frac{2}{3}$	500	583 $\frac{1}{3}$	666 $\frac{2}{3}$
11	183 $\frac{1}{3}$	275	366 $\frac{2}{3}$	458 $\frac{1}{3}$	550	641 $\frac{2}{3}$	733 $\frac{1}{3}$
12	200	300	400	500	600	700	800
13	216 $\frac{2}{3}$	325	433 $\frac{1}{3}$	541 $\frac{2}{3}$	650	758 $\frac{1}{3}$	866 $\frac{2}{3}$
14	233 $\frac{1}{3}$	350	466 $\frac{2}{3}$	583 $\frac{1}{3}$	700	816 $\frac{2}{3}$	933 $\frac{1}{3}$
15	250	375	500	625	750	875	1,000
16	266 $\frac{2}{3}$	400	533 $\frac{1}{3}$	666 $\frac{2}{3}$	800	933 $\frac{1}{3}$	1,066 $\frac{2}{3}$
17	283 $\frac{1}{3}$	425	566 $\frac{2}{3}$	708 $\frac{1}{3}$	850	991 $\frac{2}{3}$	1,133 $\frac{1}{3}$
18	300	450	600	750	900	1,050	1,200
19	316 $\frac{2}{3}$	475	633 $\frac{1}{3}$	791 $\frac{2}{3}$	950	1,108 $\frac{1}{3}$	1,266 $\frac{2}{3}$
20	333 $\frac{1}{3}$	500	666 $\frac{2}{3}$	833 $\frac{1}{3}$	1,000	1,166 $\frac{2}{3}$	1,333 $\frac{1}{3}$
21	350	525	700	875	1,050	1,225	1,400
22	366 $\frac{2}{3}$	550	733 $\frac{1}{3}$	916 $\frac{2}{3}$	1,100	1,283 $\frac{1}{3}$	1,466 $\frac{2}{3}$
23	383 $\frac{1}{3}$	575	766 $\frac{2}{3}$	958 $\frac{1}{3}$	1,150	1,341 $\frac{2}{3}$	1,533 $\frac{1}{3}$
24	400	600	800	1,000	1,200	1,400	1,600
25	416 $\frac{2}{3}$	625	833 $\frac{1}{3}$	1,041 $\frac{2}{3}$	1,250	1,458 $\frac{1}{3}$	1,666 $\frac{2}{3}$
26	433 $\frac{1}{3}$	650	866 $\frac{2}{3}$	1,083 $\frac{1}{3}$	1,300	1,516 $\frac{2}{3}$	1,733 $\frac{1}{3}$
27	450	675	900	1,125	1,350	1,575	1,800
28	466 $\frac{2}{3}$	700	933 $\frac{1}{3}$	1,166 $\frac{2}{3}$	1,400	1,633 $\frac{1}{3}$	1,866 $\frac{2}{3}$
29	483 $\frac{1}{3}$	725	966 $\frac{2}{3}$	1,208 $\frac{1}{3}$	1,450	1,691 $\frac{2}{3}$	1,933 $\frac{1}{3}$
30	500	750	1,000	1,250	1,500	1,750	2,000

GROUTING WORK TABLE OF GALLONS REQUIRED

Width of Roadway in Feet.	PER MILE OF LENGTH.						
	Gallons per Square Yard.						
	$\frac{1}{8}$	$\frac{1}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2
2	586 $\frac{2}{3}$	880	1,173 $\frac{1}{3}$	1,466 $\frac{2}{3}$	1,760	2,053 $\frac{1}{3}$	2,346 $\frac{2}{3}$
3	880	1,320	1,760	2,200	2,640	3,080	3,520
4	1,173 $\frac{1}{3}$	1,760	2,346 $\frac{2}{3}$	2,933 $\frac{1}{3}$	3,520	4,106 $\frac{2}{3}$	4,693 $\frac{1}{3}$
5	1,466 $\frac{2}{3}$	2,200	2,933 $\frac{1}{3}$	3,666 $\frac{2}{3}$	4,400	5,133 $\frac{1}{3}$	5,866 $\frac{2}{3}$
6	1,760	2,640	3,520	4,400	5,280	6,160	7,040
7	2,053 $\frac{1}{3}$	3,080	4,106 $\frac{2}{3}$	5,133 $\frac{1}{3}$	6,160	7,186 $\frac{2}{3}$	8,213 $\frac{1}{3}$
8	2,346 $\frac{2}{3}$	3,520	4,693 $\frac{1}{3}$	5,866 $\frac{2}{3}$	7,040	8,213 $\frac{1}{3}$	9,386 $\frac{2}{3}$
9	2,640	3,960	5,280	6,600	7,920	9,240	10,560
10	2,933 $\frac{1}{3}$	4,400	5,866 $\frac{2}{3}$	7,333 $\frac{1}{3}$	8,800	10,266 $\frac{2}{3}$	11,733 $\frac{1}{3}$
11	3,226 $\frac{2}{3}$	4,840	6,453 $\frac{1}{3}$	8,066 $\frac{2}{3}$	9,680	11,293 $\frac{1}{3}$	12,906 $\frac{2}{3}$
12	3,520	5,280	7,040	8,800	10,560	12,320	14,080
13	3,813 $\frac{1}{3}$	5,720	7,626 $\frac{2}{3}$	9,533 $\frac{1}{3}$	11,440	13,346 $\frac{2}{3}$	15,253 $\frac{1}{3}$
14	4,106 $\frac{2}{3}$	6,160	8,213 $\frac{1}{3}$	10,266 $\frac{2}{3}$	12,320	14,373 $\frac{1}{3}$	16,426 $\frac{2}{3}$
15	4,400	6,600	8,800	11,000	13,200	15,400	17,600
16	4,693 $\frac{1}{3}$	7,040	9,386 $\frac{2}{3}$	11,733 $\frac{1}{3}$	14,080	16,426 $\frac{2}{3}$	18,773 $\frac{1}{3}$
17	4,986 $\frac{2}{3}$	7,480	9,973 $\frac{1}{3}$	12,466 $\frac{2}{3}$	14,960	17,453 $\frac{1}{3}$	19,946 $\frac{2}{3}$
18	5,080	7,920	10,560	13,200	15,840	18,480	21,120
19	5,573 $\frac{1}{3}$	8,360	11,146 $\frac{2}{3}$	13,933 $\frac{1}{3}$	16,720	19,506 $\frac{2}{3}$	22,293 $\frac{1}{3}$
20	5,866 $\frac{2}{3}$	8,800	11,733 $\frac{1}{3}$	14,666 $\frac{2}{3}$	17,600	20,533 $\frac{1}{3}$	23,466 $\frac{2}{3}$
21	6,160	9,240	12,320	15,400	18,480	21,560	24,640
22	6,453 $\frac{1}{3}$	9,680	12,906 $\frac{2}{3}$	16,133 $\frac{1}{3}$	19,360	22,586 $\frac{2}{3}$	25,813 $\frac{1}{3}$
23	6,746 $\frac{2}{3}$	10,120	13,493 $\frac{1}{3}$	16,866 $\frac{2}{3}$	20,240	23,613 $\frac{1}{3}$	26,986 $\frac{2}{3}$
24	7,040	10,560	14,080	17,600	21,120	24,640	28,160
25	7,333 $\frac{1}{3}$	11,000	14,666 $\frac{2}{3}$	18,333 $\frac{1}{3}$	22,000	25,66 $\frac{2}{3}$	29,333 $\frac{1}{3}$
26	7,626 $\frac{2}{3}$	11,440	15,253 $\frac{1}{3}$	19,066 $\frac{2}{3}$	22,880	26,693 $\frac{1}{3}$	30,506 $\frac{2}{3}$
27	7,920	11,880	15,840	19,800	23,760	27,720	31,680
28	8,213 $\frac{1}{3}$	12,320	16,426 $\frac{2}{3}$	20,533 $\frac{1}{3}$	24,640	28,746 $\frac{2}{3}$	32,853 $\frac{1}{3}$
29	8,506 $\frac{2}{3}$	12,760	17,013 $\frac{1}{3}$	21,266 $\frac{2}{3}$	25,520	29,773 $\frac{1}{3}$	34,026 $\frac{2}{3}$
30	8,800	13,200	17,600	22,000	26,400	30,800	35,200

CHIPPINGS

AREAS COVERED OR TONS REQUIRED

Tons	ONE TON TO COVER.					
	60 sq. yds.	70 sq. yds.	80 sq. yds.	90 sq. yds.	100 sq. yds.	110 sq. yds.
1	60	70	80	90	100	110
2	120	140	160	180	200	220
3	180	210	240	270	300	330
4	240	280	320	360	400	440
5	300	350	400	450	500	550
6	360	420	480	540	600	660
7	420	490	560	630	700	770
8	480	560	640	720	800	880
9	540	630	720	810	900	990
10	600	700	800	900	1,000	1,100
20	1,200	1,400	1,600	1,800	2,000	2,200
30	1,800	2,100	2,400	2,700	3,000	3,300
40	2,400	2,800	3,200	3,600	4,000	4,400
50	3,000	3,500	4,000	4,500	5,000	5,500
60	3,600	4,200	4,800	5,400	6,000	6,600
70	4,200	4,900	5,600	6,300	7,000	7,700
80	4,800	5,600	6,400	7,200	8,000	8,800
90	5,400	6,300	7,200	8,100	9,000	9,900
100	6,000	7,000	8,000	9,000	10,000	11,000
125	7,500	8,750	10,000	11,250	12,500	13,750
150	9,000	10,500	12,000	13,500	15,000	16,500
175	10,500	12,250	14,000	15,750	17,500	19,250
200	12,000	14,000	16,000	18,000	20,000	22,000
225	13,500	15,750	18,000	20,250	22,500	24,750
250	15,000	17,500	20,000	22,500	25,000	27,500
275	16,500	19,250	22,000	24,750	27,500	30,250
300	18,000	21,000	24,000	27,000	30,000	33,000
325	19,500	22,750	26,000	29,250	32,500	35,750
350	21,000	24,500	28,000	31,500	35,000	38,500
375	22,500	26,250	30,000	33,750	37,500	41,250
400	24,000	28,000	32,000	36,000	40,000	44,000
425	25,500	29,750	34,000	38,250	42,500	46,750
450	27,000	31,500	36,000	40,500	45,000	49,500
475	28,500	33,250	38,000	42,750	47,000	52,250
500	30,000	35,000	40,000	45,000	50,000	55,000

CHIPPINGS

AREAS COVERED OR TONS REQUIRED

Tons	ONE TON TO COVER.					
	120 sq. yds.	130 sq. yds.	140 sq. yds.	150 sq. yds.	160 sq. yds.	170 sq. yds.
1	120	130	140	150	160	170
2	240	260	280	300	320	340
3	360	390	420	450	480	510
4	480	520	560	600	640	680
5	600	650	700	750	800	850
6	720	780	840	900	960	1,020
7	840	910	980	1,050	1,120	1,190
8	960	1,040	1,120	1,200	1,280	1,360
9	1,080	1,170	1,260	1,350	1,440	1,530
10	1,200	1,300	1,400	1,500	1,600	1,700
20	2,400	2,600	2,800	3,000	3,200	3,400
30	3,600	3,900	4,200	4,500	4,800	5,100
40	4,800	5,200	5,600	6,000	6,400	6,800
50	6,000	6,500	7,000	7,500	8,000	8,500
60	7,200	7,800	8,400	9,000	9,600	10,200
70	8,400	9,100	9,800	10,500	11,200	11,900
80	9,600	10,400	11,200	12,000	12,800	13,600
90	10,800	11,700	12,600	13,500	14,400	15,300
100	12,000	13,000	14,000	15,000	16,000	17,000
125	15,000	16,250	17,500	18,750	20,000	21,250
150	18,000	19,500	21,000	22,500	24,000	25,500
175	21,000	22,750	24,500	26,250	28,000	29,750
200	24,000	26,000	28,000	30,000	32,000	34,000
225	27,000	29,250	31,500	33,750	36,000	38,250
250	30,000	32,500	35,000	37,500	40,000	42,500
275	33,000	35,750	38,500	41,250	44,000	46,750
300	36,000	39,000	42,000	45,000	48,000	51,000
325	39,000	42,250	45,500	48,750	52,000	55,250
350	42,000	45,500	49,000	52,500	56,000	59,500
375	45,000	48,750	52,500	56,250	60,000	63,750
400	48,000	52,000	56,000	60,000	64,000	68,000
425	51,000	55,250	59,500	63,750	68,000	72,250
450	54,000	58,500	63,000	67,500	72,000	76,500
475	57,000	61,750	66,500	71,250	76,000	80,750
500	60,000	65,000	70,000	75,000	80,000	85,000

SURFACE DRESSING

TABLE OF GALLONS REQUIRED

Width of Road- way.	PER 100 YARDS OF LENGTH.					PER MILE OF LENGTH.				
	Square Yards per Gallon.					Square Yards per Gallon.				
	3	4	5	6	7	3	4	5	6	7
2	22	16½	13	11	10	391	294	235	196	168
3	33½	25	20	17	15	587	440	352	293	251
4	44	33	27	22	19	782	587	469	391	335
5	55½	42	33	28	24	978	734	587	489	419
6	67	50	40	34	29	1,173	880	704	587	503
7	78	58	47	39	34	1,369	1,027	821	684	587
8	89	67	54	45	38	1,564	1,174	939	782	670
9	100	75	60	50	43	1,760	1,320	1,056	880	754
10	111	83	67	56	48	1,956	1,468	1,173	978	838
11	122	92	74	61	53	2,151	1,614	1,291	1,076	922
12	133	100	80	67	58	2,346	1,760	1,408	1,173	1,006
13	144½	108	87	73	62	2,542	1,907	1,525	1,271	1,090
14	156	116	94	78	67	2,737	2,054	1,643	1,369	1,173
15	167	125	100	84	72	2,933	2,200	1,760	1,467	1,257
16	178	133	107	89	77	3,128	2,347	1,877	1,564	1,341
17	189	142	114	95	81	3,324	2,494	1,995	1,662	1,425
18	200	150	120	100	86	3,520	2,640	2,112	1,760	1,509
19	211	158	127	106	91	3,715	2,787	2,229	1,858	1,592
20	222	167	134	111	95	3,912	2,933	2,347	1,956	1,676
21	233	175	140	117	100	4,106	3,080	2,464	2,053	1,760
22	244½	183	147	123	105	4,302	3,227	2,581	2,151	1,844
23	256	192	154	128	110	4,497	3,374	2,699	2,249	1,928
24	267	200	160	134	115	4,693	3,520	2,816	2,347	2,011
25	278	208	167	139	119	4,889	3,667	2,933	2,444	2,095
26	289	217	174	145	124	5,085	3,814	3,051	2,542	2,179
27	300	225	180	150	129	5,280	3,960	3,168	2,640	2,263
28	311	233	187	156	134	5,476	4,107	3,285	2,738	2,347
29	322	242	194	161	138	5,671	4,254	3,403	2,836	2,431
30	333½	250	200	167	143	5,867	4,400	3,520	2,933	2,515

GRANITE KERB AND CHANNELS

4" x 10" Edge Kerb	-	-	44 lineal feet per ton.
4" x 12" " "	-	-	40 " " "
5" x 12" " "	-	-	32 " " "
6" x 12" " "	-	-	28 " " "
12" x 6" Flat Kerb	-	-	28 " " "
10" x 4" Channel	-	-	44 " " "
12" x 4" " "	-	-	40 " " "
12" x 6" " "	-	-	28 " " "

CAMBER OF ROADS

Waterbound Roads with Colas sealing coat	1 in 28-32
Colas grouted roads	1 in 32-36

SPREADING OF METAL

1 ton of 2" to $\frac{3}{4}$ " Granite consolidated to one stone thickness covers about 16 sq. yds.

1 ton of 2" to $\frac{3}{4}$ " Granite consolidated to 2" covers about 12 super yards.

1 ton of 2" to $\frac{3}{4}$ " Granite consolidated to 3" covers about 8 super yards.

WEIGHTS AND MEASURES

LONG MEASURE

	Inches.	Feet.	Yards.	Fathoms.	Rods, Poles or Perches.	Furlongs.	Miles.
Ft. -	12 =	1 =	.333 =	.167 =	.0607 =	.0015 =	.0002
Yds. -	36 =	3 =	1 =	.5 =	.1818 =	.0045 =	.0006
Fths. -	72 =	6 =	2 =	1 =	.3636 =	.009 =	.0011
Rods. -	198 =	16.5 =	5.5 =	2.75 =	1 =	.025 =	.003125
Furs. -	7920 =	660 =	220 =	110 =	40 =	1 =	.125
Mls. -	63360 =	5280 =	1760 =	880 =	320 =	8 =	1

				Inches.	Links.	Poles.	Chains.	Furlongs.	Miles.
Lks.	-	-	-	7.92 =	1 =	.04 =	.01 =	.001 =	.000125
Pls.	-	-	-	198 =	25 =	1 =	.25 =	.025 =	.003125
Chns.	-	-	-	792 =	100 =	4 =	1 =	.1 =	.0125
Furs.	-	-	-	7920 =	1000 =	40 =	10 =	1 =	.125
Mls.	-	-	-	66360 =	8000 =	320 =	80 =	8 =	1

SQUARE MEASURE

	Sq. Ins.	Sq. Ft.	Sq. Yds.	Sq. Rods.	Roods.	Acres.
Sq. Ins.	1 =	.0069	—	—	—	—
Sq. Ft.	144 =	1 =	.1111 =	—	—	—
Sq. Yds.	1296 =	9 =	1 =	—	—	—
Sq. Rds.	39204 =	272.25 =	30.25 =	1 =	.025 =	.00625
Roods	1568160 =	10890 =	1210 =	40 =	1 =	.25
Acres	6272640 =	43560 =	4840 =	160 =	4 =	1
Sq. Mls.	—	—	—	102400 =	2560 =	640 =
						= 1 Sq. Mile

	Sq. Ins.	Sq. Links.	Sq. Rods.	Sq. Chains.	Roods.	Acres.
Sq. In.	1 =	.016	—	—	—	—
Sq. Link	62.7 =	1 =	.00162 =	.0001 =	.00004 =	.00001
Sq. Rod	39200 =	625 =	1 =	.0617 =	.025 =	.00625
Sq. Chn.	—	10000 =	16.2 =	1 =	.4 =	.1
Rood	—	25000 =	40.5 =	2.5 =	1 =	.25
Acre	—	100000 =	162 =	10 =	4 =	1

SOLID MEASURE

	Cubic Inches.	Cubic Feet.	Cubic Yards.
Cubic Inch	-	-	-
Cubic Foot	-	-	-
Cubic Yard	-	-	-
	1 =	.00058 =	.00002
	1728 =	1 =	.03704
	46656 =	27 =	1



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